IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Before the Board of Patent Appeals and Interferences

Appellants:	William M. Ayers	)
		) Group Art Unit: 1753
Serial No.:	09/720,663	)
		)
Filed:	August 6, 2001	)
		)
For:	METHOD AND APPARATUS FOR THE PREPARATION OF HIGH PURITY PHOSPHINE OR OTHER GAS	) Examiner: Kishor Mayekar
		)
Docket No.:	9017-15	)

BRIEF FOR AYERS

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

Applicants appeal from the final rejection dated June 7, 2007 of claims 11-21 and 32-50 of this application. This appeal applies to each of these claims.

Real Party in Interest

Air Products and Chemicals, Inc. is the Real Party in Interest.

Related Appeals and Interferences

There are no related appeals or interferences.

Status of Claims

Claims cancelled: 1-10, 22-31

Claims pending: 11-21 and 32-50

Claims on appeal: 11-21 and 32-50

Status of Amendments

No amendments were presented subsequent to the final office action forming the basis for appeal.

Summary of Claimed Subject Matter

The invention presently claimed relates to systems for producing phosphine or other high purity gases for introduction into processes in which semiconductors are manufactured or doped. See, page 5, lines 3-6. Prior art systems had utilized electrochemical generators to produce such gases. To the contrary, the system presently claimed utilizes a microwave-based generator to produce the gases. In particular, three independent claims are pending, each directed to a chemical reactor system for the generation of gas – claims 11, 32 and 41.

Independent claim 11 is directed to a chemical reactor system for generation of high purity gas. The system includes a source of microwave radiation (Fig. 1, character 2; Fig. 2. character 24; Fig. 3, top; pages/lines 10/16-17, 13/3), a microwave transparent, gas tight barrier (Fig. 1, character 1; Figure 2, character 22; Fig. 4, top; pages/lines 10/13-14, 12/36), a microwave reflecting enclosure (Fig. 1, character 4; Fig. 2, character 21, Fig. 3, character 32; pages/lines 10/18-20, 12/34, 13/20) into which said source of microwave radiation is directed through said gas tight barrier and into a reaction zone (Fig. 1, character 1; Fig. 2, character 21; Fig. 3, character 31; pages/lines 10/13, 12/34, 13/19) within the microwave reflecting enclosure. The system also includes a manifold

for gas delivery adapted to receive generated gas from said enclosure (Fig. 1, character line exiting top of tube 1; Fig. 2, character line exiting bottom left of vessel 21; Fig. 3, character line exiting top left of vessel 32; pages/lines 11/25, 13/31), a solvent vapor removal device (Fig. 1, character 7; pages/lines 11/26-28, 13/30-34) adapted to remove solvent vapor from the generated gas, and a gas concentration sensor for sensing gas concentration in the generated gas (Fig. 1, character 11; pages/lines 11/35, 13/30-34). Further provided is a feed-back control system adapted to control gas generation rate in the enclosure (Fig. 1, character 10, pages/lines 5/22-25, 6/26-31, 11/20-23, 13/30-34), and a supply vessel (Fig. 1, character 6, Fig. 2, "Feed"; Fig. 3, "Feed"; pages/lines 10/28) for containing a precursor material for forming said gas, said supply vessel fluidly connected to said reaction zone for feed of the precursor material to the reaction zone to generate the high purity gas. Further, the system is configured to generate the high purity gas containing no more than 100 parts per million water vapor (pages/lines 11/29-31, 13/30-34).

Independent claim 32 is directed to a chemical reactor system for generation of high purity gas for semiconductor fabrication. The system includes a source of microwave radiation (Fig. 1, character 2; Fig. 2. character 24; Fig. 3, top; pages/lines 10/16-17, 13/3) and a reaction chamber for receiving a precursor material for generating said gas (Fig. 1, character 1; Fig. 2, character 21; Fig. 3, character 31; pages/lines 10/13, 12/34, 13/19), the reaction chamber adapted to generate the gas under pressure (pages/lines 6/4, 11/31-33, 12/24-29, 12/34-35, 13/8-14). The system includes a microwave transparent, gas tight barrier (Fig. 1, character 1; Figure 2, character 22; Fig. 4, top; pages/lines 10/13-14, 12/36) through which the source of microwave radiation is directed into the reaction chamber, and a microwave reflecting enclosure (Fig. 1, character 4; Fig. 2, character 21, Fig. 3, character 32; pages/lines 10/18-20, 12/34, 13/20) into which the source of microwave radiation is directed. The system also includes a manifold for gas delivery adapted to receive the generated gas (Fig. 1, character line exiting top of tube 1; Fig. 2, character line exiting bottom left of vessel 21; Fig. 3, character line exiting top left of vessel 32; pages/lines 11/25, 13/31), a gas concentration

sensor for sensing gas concentration in the generated gas (Fig. 1, character 11; pages/lines 11/35, 13/30-34) and a solvent vapor removal device adapted to remove solvent vapor from the generated gas (Fig. 1, character 7; pages/lines 11/26-28, 13/30-34), and is configured to generate the high purity gas containing no more than 100 parts per million of water vapor (pages/lines 11/29-31, 13/30-34).

Independent claim 41 is directed to a chemical reactor system for generation of a gas. The system includes a source of microwave radiation (Fig. 1, character 2; Fig. 2. character 24; Fig. 3, top; pages/lines 10/16-17, 13/3) and a reaction chamber for receiving a precursor material for generating said gas (Fig. 1, character 1; Fig. 2, character 21; Fig. 3, character 31; pages/lines 10/13, 12/34, 13/19), the reaction chamber adapted to generate the gas under pressure (pages/lines 6/4, 11/31-33, 12/24-29, 12/34-35, 13/8-14). The system also includes a microwave transparent, gas tight barrier (Fig. 1, character 1; Figure 2, character 22; Fig. 4, top; pages/lines 10/13-14, 12/36) through which the source of microwave radiation is directed into the reaction chamber, and a microwave reflecting enclosure (Fig. 1, character 4; Fig. 2, character 21, Fig. 3, character 32; pages/lines 10/18-20, 12/34, 13/20) into which the source of microwave radiation is directed. The system also includes a manifold for gas delivery adapted to receive the generated gas (Fig. 1, character line exiting top of tube 1; Fig. 2, character line exiting bottom left of vessel 21; Fig. 3, character line exiting top left of vessel 32; pages/lines 11/25, 13/31), a solvent vapor removal device adapted to remove solvent vapor from the generated gas (Fig. 1, character 7; pages/lines 11/26-28, 13/30-34), and a supply vessel (Fig. 1, character 6, Fig. 2, "Feed"; Fig. 3, "Feed"; pages/lines 10/28) fluidly connected to the reaction chamber and adapted to feed the precursor material to the reaction chamber for generation of the gas. Further, the system is configured to generate the gas containing no more than 100 parts per million of water vapor (pages/lines 11/29-31, 13/30-34).

The independent claims establish chemical reactor systems set up for generation of a high purity, low water vapor gas, as would be useful in the semiconductor fabrication industry. Specifically as an illustration, with a microwave gas generation system as described in Example 1 beginning on page 14 of the application, Dr. Ayers, the inventor

on the present application, has been able to produce 850 cc/min of phosphine with only 850 watts or 1.0 cc/min-watt. To compare this to the conventional electrochemical generation, as has been discussed of record in the parent PCT application to this case, 930 cc/min of phosphine would be produced with an electrochemical phosphine generation cell operating at 200 amperes and 6 volts, with 100% current efficiency. The power required for such process would be 1200 watts (200 times 6) or 0.78 cc/min-watt. However, the electrochemical generation approach never reaches 100% current efficiency because some of the current goes into electrochemical hydrogen production. A typical efficiency for electrochemical phosphine production is about 60%. Hence, the power efficiency is even lower in electrochemical generation systems, about 0.47 cc/min-watt (0.60 times 0.78 cc/min-watt). Accordingly, microwave generation systems as claimed are significantly more efficient in the generation of phosphine and similar gases than corresponding electrochemical generation systems. Further, the scale-up of a microwave system is more readily accomplished than for electrochemical apparatuses. High current DC power supplies are expensive and large, and would be required for scaled-up electrochemical systems. In addition, large bus bars or cables would have to be used to carry the current to the electrochemical system. Contrasted to this, 1000 watt microwave sources are relatively inexpensive and small, and because they operate with standard alternating current, they also do not require large cables like DC power supplies used in electrochemical systems. Accordingly, the present inventor has made a significant advance in systems for the generation of high purity gases useful in semiconductor fabrication.

Grounds of Rejection to be Reviewed

1) Whether the Examiner has made any *prima facie* showing to substantiate a rejection of claims 45 and 46.

2) Whether claims 11-21 are obvious under 35 U.S.C. 103(a) over Moisan et al. (U.S. 6,224,836) in view of Mutterer, Jr. et al. (U.S. 6,258,329).

3) Whether claims 32-34, 37-44 and 49 are obvious under 35 U.S.C. 103(a) over Moisan et al. in view of Mutterer, Jr. et al., Warmbier (U.S. 5,540,886) and/or Lautenschlager et al. (U.S. 6,033,912).

4) Whether claims 35 and 36 are obvious under 35 U.S.C. 103(a) over Moisan et al. in view of Mutterer, Jr. et al., Warmbier and/or Lautenschlager and further in view of Ayers (U.S. 5,158,656).

5) Whether claims 47 and 50 are obvious under 35 U.S.C. 103(a) over Moisan et al. in view of Mutterer, Jr. et al., Warmbier and/or Lautenschlager et al. and further in view of WO 95/11750.

6) Whether claim 48 is unpatentable under 35 U.S.C. § 103(a) over Moisan et al. in view of Mutterer, Jr. et al., Warmbier and/or Lautenschlager et al. and further in view of Easly et al. (U.S. 3,889,182).

Argument

A. Summary of the Argument

All of the present claims are directed to systems for the generation of gas, such as phosphine, wherein the systems utilize a source of microwave radiation and are configured to generate the gas containing no more than 100 ppm of water vapor. Such high purity gases are useful for semiconductor fabrication. There are five rejections of record, all under 35 U.S.C. §103. The primary and secondary reference in each of the five rejections are Moisan et al., U.S. 6,224,836 and Mutterer, Jr. et al., U.S. 6,258,329, respectively. Moisan et al. relates to waste gas processing and Mutterer, Jr. et al. relates

to equipment for evaporating liquids from samples. Neither relates in any way to systems for generating high purity gas for semiconductor fabrication. Additional cited references in the rejections include Warmbier, U.S. 5,540,886 and Lautenschlager et al., U.S. 6,033,912. Like Moisan et al., these references also relate to waste gas processing systems. Ayers, U.S. 5,158,656 is cited as a tertiary reference in one rejection (of claims 35 and 36) and is the only reference of record that is in the field of gas generators for semiconductor fabrication. None of the references outside the field of semiconductor fabrication suggests the use of their systems for generating gases useful in semiconductor fabrication (as noted, they are waste gas processing systems or simple evaporation systems), and the Ayers reference expressly directs the skilled artisan to use an electrochemical generator, not a microwave-based generator, when generating gases for semiconductor fabrication. Thus, none of the references, alone or combined, remotely suggests utilizing a microwave-based system for the generation of high purity gases useful in semiconductor fabrication, much less the specific systems claimed.

Moreover, contrary to the Examiner's assertion, the Moisan et al. reference does not teach the limitation that the "system is configured to generate said high purity gas containing no more than 100 ppm of water vapor", a limitation that is present in all of the independent claims. Moisan et al. is directed to waste gas processing. The Examiner has not explained why someone processing waste gases would necessarily want to render them highly pure as regards water vapor, as required by the claims. This in fact would not appear to be a requirement or particular desire in Moisan et al., as the goal of the system design is simply to process waste gases to render them safer, and water vapor is not a particular concern in this regard.

Still further, not only are the claimed systems not suggested in the prior art, they provide significant advantages in the generation of gases for semiconductor fabrication. This is demonstrated, for instance, in the Example beginning at page 14 of the application (and discussed in the Summary of the Invention section above). Thus, in the present circumstance, the rejections do not properly account for limitations of the claims rendering the systems specifically useful for generation of high purity gases for

semiconductor fabrication, and do not properly account for significant advantages provided by the invention in the field of semiconductor fabrication.

The Examiner's rejections under 35 U.S.C. §103 should be reversed.

B. An Overview of Pertinent Law

(i) Anticipation

A prior art reference does not anticipate a patent claim unless the reference discloses all of the limitations of the claims. Kallman v. Kimberly-Clark Corp., 713 F2d 760, 771, 218 USPQ 781, 789 (Fed. Cir. 1983). A limitation cannot be found to be inherent in a reference unless that limitation necessarily occurs in the reference. As the Court stated in In re Oelrich, 666 F.2d 578, 581, 212 USPQ 323, 326 (CCPA 1981): "Inherency ... may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient."

(ii) Obviousness

When rejecting claims under 35 U.S.C. § 103, "the Examiner bears the burden of establishing a *prima facie* case of obviousness based upon the prior art." In re Fritch, 23 U.S.P.Q. 2d 1780, 1783 (Fed. Cir. 1992).[1] To establish a *prima facie* case of obviousness, the Examiner must provide objective evidence 1) of some suggestion or motivation to combine or modify one or more prior art references,[2] 2) that the suggested combination or modification has a reasonable expectation of success,[3] and 3) that the prior art reference or references, when combined, suggest or teach all of applicant's claim limitations. MPEP § 2143. As held by the Federal Circuit, "[t]hese findings or evidence must be specific, clear, and particular." In re Lee, 61 U.S.P.Q. 2d 1430, 1433-34 (Fed.

[1] Citing In re Piasecki and Meyers, 223 U.S.P.Q. 785, 787-88 (Fed. Cir. 1984).

[2] This motivation is sometimes found in the references themselves but can also be found within the body of knowledge available to a person of ordinary skill in the art at the time applicant's invention was conceived. See, MPEP § 2142; and KSR International Co. v. Teleflex, Inc., et al., 127 S. Ct. 1727 (2007).

Cir. 2002). "Broad conclusory statements regarding the teaching of multiple references, standing alone, are not [considered sufficient] 'evidence'[4]" to support a finding of *prima facie* obviousness. In re Dembiczak, 50 U.S.P.Q. 2d 1614, 1617 (Fed. Cir. 1999); See also, Ex Parte Levengood, 28 U.S.P.Q. 2d 1300, 1301 (Bd. Pat. App. & Int. 1993).

Obviousness determinations must be performed without "entry into the 'tempting but forbidden zone of hindsight.'" Dembiczak, 50 U.S.P.Q. 2d at 1616 (Fed. Cir. 1999).[5] More specifically, in Dembiczak, the Federal Circuit offered the following guidance:

> [m]easuring a claimed invention against the standard established by section 103 requires the oft-difficult but critical step of casting the mind back to the time of invention, to consider the thinking of one of ordinary skill in the art, guided only by the prior art references and the then-accepted wisdom in the field.[6] . . .

Dembiczak, 50 U.S.P.A. 2d at 1617.[7]

The Examiner, when relying on a motivation to modify that originates within the general knowledge of one of ordinary skill in the art, must take care to make specific evidentiary findings regarding positive motivation. See, In re Goodwin, Margrave, and Wagner, 198 U.S.P.Q. 1, 3 (C.C.P.A. 1978); Fine, 5 U.S.P.Q. 2d at 1599; and MPEP § 2143.01. As summarized in the MPEP,

> [a] statement that modifications of the prior art to meet the claimed invention would have been "well within the ordinary skill of the art at the time the claimed invention was made" because the references relied upon teach that all aspects of the claimed invention were individually known in

---

[3] "Both the suggestion and the reasonable expectation of success must be founded in the prior art, not in the applicant's disclosure." In re Vaeck, 20 U.S.P.Q. 2d 1438, 1442 (Fed. Cir. 1991) (citing In re Dow Chemical Co., 5 U.S.P.Q. 2d 1529, 1531 (Fed. Cir. 1988)).

[4] E.g., McElmurry v. Arkansas Power & Light Co., 995 F.2d 1576, 1578, 27 U.S.P.Q. 2d 1129, 1131 (Fed. Cir. 1993) ("Mere denials and conclusory statements, however, are not sufficient to establish a genuine issue of material fact.") [citation omitted].

[5] Quoting Loctite Corp. v. Ultraseal Ltd., 228 U.S.P.Q. 90, 98 (Fed. Cir. 1998) (overruled on other grounds).

[6] [citation omitted].

[7] Citing C.R. Bard, Inc. v. M3 Sys., Inc., 48 U.S.P.Q. 2d 1225, 1232 (Fed. Cir. 1998) (describing "teaching or suggestion or motivation [to combine]" as an "essential evidentiary component of an obviousness holding.")).

> the art is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references.

MPEP § 2143.01.[8]

C. Detailed Arguments

Issue 1 *Whether the Examiner has made any prima facie showing to substantiate the rejection of claims 45 and 46.*

The Summary Sheet of the Office Action indicates that claims 45 and 46 are rejected. However, the Office Action does not include claims 45 and 46 in any of its stated rejections or otherwise provide any reason at all for the rejection of these claims. The initial burden is upon the Patent Office to establish a *prima facie* case that claims are unpatentable. No such case is provided in the Office Action. Reversal of the rejection of claims 45 and 46 is therefore solicited.

Issue 2 *Whether claims 11-21 are obvious under 35 U.S.C. 103(a) over Moisan et al. (U.S. 6,224,836) in view of Mutterer, Jr. et al. (U.S. 6,258,329).*

Claims 11-21

The Patent Office bears the initial burden of establishing that a claimed invention is *prima facie* obvious. To do so, the Examiner must show that each element of the claim is taught or suggested, expressly or inherently, by a combination of references. In doing so, a limitation cannot be found to be inherent in a reference unless that limitation *necessarily* occurs in the reference. Probabilities or possibilities are not enough. Certainty is required. Further, in finding a limitation present, the reasoning of the Examiner must be clear and particular.

The combination of references above does not teach or suggest the following limitation contained in each of claims 11-21: "wherein said system is configured to

[8] Citing Ex parte Levengood, 28 U.S.P.Q. 2d 1300 (Bd. Pat. App. & Inter. 1993).

generate said high purity gas containing no more than 100 ppm of water vapor". The Examiner asserts that Moison et al. teaches this limitation. The Examiner's entire stated basis for this conclusion is: "Moison's device is capable of generating a high purity gas as claimed and inherently possesses the added claimed feature."

There is no explanation from the Examiner as to why the Examiner concludes that Moison's device necessarily possesses this feature. No clear and particular findings on the point are provided by the Examiner, as required by the relevant case law. In fact, such a low water vapor specification would not necessarily have to occur with Moison et al.'s device because it is not designed for producing a high purity gas at all. Rather, the device of Moison et al. takes an input gas having harmful chemicals, breaks those chemicals down to create a safer exhaust gas, bubbles the exhaust gas through an aqueous slurry, and then passes the gas through a "dehydration unit". The Moison et al. reference is completely silent as to the specifications for the dehydration unit. The Examiner has not put forth any reason or evidence that all dehydration units are capable of treating the input stream contemplated in Moison et al. and thereby producing an output stream having such a low water vapor content as claimed (100 ppm or less). As noted, such a low water vapor specification would not appear to be necessary to the processes described in Moison et al. It is clear, therefore, that Moison fails to teach the above-identified limitation of claims 11-21.

Further, the Examiner has not alleged that this limitation is inherent or taught in the secondary reference, Mutterer, Jr. et al. In fact this secondary reference does not teach such a stringent specification, and does not deal with creating a high purity gas. Instead, the Mutterer, Jr. et al. reference deals with a system for the evaporation of solvents from samples. Thus, similar to the Moisan et al. system, the system of Mutterer, Jr. et al. would have no need to be effective to achieve such a stringent water vapor specification as claimed.

<u>Claim 16</u>

Claim 16 adds the further limitation of "a precursor material received in said supply vessel, and wherein the precursor material is selected from the group consisting of

hypophosphorous acid, hypophosphoric acid, and an alkaline slurry of red phosphorous." The references relied upon in no way teach or suggest this claim limitation. The Examiner has refused to give this limitation weight, despite the fact that it is a positively recited element of the claimed system. All elements of a claim must be taken into account when determining obviousness. The precursor material is an active component of the claimed system – it is reacted to produce the generated gas itself (in this case, phosphine), and must be accounted for in the obviousness determination. Because the references do not teach or suggest the claimed system including the precursor material, the Examiner's rejection of claim 16 is erroneous for this further reason.

For at least these reasons, it is submitted that the rejection of claims 11-21 under 35 U.S.C. §103 is erroneous and should be reversed.

Issue 3 *Whether claims 32-34, 37-44 and 49 are obvious under 35 U.S.C. 103(a) over Moisan et al. in view of Mutterer, Jr. et al., Warmbier (U.S. 5,540,886) and/or Lautenschlager et al. (U.S. 6,033,912).*

The Patent Office bears the initial burden of establishing that a claimed invention is *prima facie* obvious. To do so, the Examiner must show that each element of the claim is taught or suggested, expressly or inherently, by a combination of references. In doing so, a limitation cannot be found to be inherent in a reference unless that limitation *necessarily* occurs in the reference. Probabilities or possibilities are not enough. Certainty is required.

The combination of references above does not teach or suggest the following limitation contained in each of claims 11-21: "wherein said system is configured to generate said high purity gas containing no more than 100 ppm of water vapor". The Examiner asserts that Moison et al. teaches this limitation. The Examiner's entire stated basis for this conclusion is: "Moison's device is capable of generating a high purity gas as claimed and inherently possesses the added claimed feature."

There is no explanation from the Examiner as to why the Examiner concludes that Moison's device necessarily possesses this feature. In fact, such a low water vapor

specification would not necessarily have to occur with Moison et al.'s device because it is not designed for producing a high purity gas at all. Rather, the device of Moison et al. takes an input gas having harmful chemicals, breaks those chemicals down to create a safer exhaust gas, bubbles the exhaust gas through an aqueous slurry, and then passes the gas through a "dehydration unit". The Moison et al. reference is completely silent as to the specifications for the dehydration unit. The Examiner has not put forth any reason or evidence that all dehydration units are capable of treating the input stream contemplated in Moison et al. and thereby producing an output stream having such a low water vapor content as claimed (100 ppm or less). As noted, such a low water vapor specification would not appear to be necessary to the processes described in Moison et al. It is clear, therefore, that Moison fails to teach the above-identified limitation of claims 11-21.

Further, the Examiner has not alleged that this limitation is inherent or taught in any of the secondary references. In fact the secondary references do not teach such a stringent specification, and do not deal with creating a high purity gas. Instead, the Mutterer, Jr. et al. reference deals with a system for the evaporation of solvents from samples, and the systems of Warmbier and Lautenschlager concern the field of treatment of waste gas streams. Thus, similar to the Moisan et al. system, the systems of the secondary references would have no need to be effective to achieve such a stringent water vapor specification as claimed.

Still further, these rejected claims require that the reaction chamber be adapted to generate the gas under pressure. In addressing this limitation, the Examiner states that "...since Moison's device is not operated under a vacuum or at atmospheric pressure and since the gaseous effluent is introduced into the device via one of its ends and has to be under pressure, Moison's reaction chamber would also be under pressure in the absence of evidence to the contrary." However, the express teaching of Moison et al. is that its device <u>does operates at atmospheric pressure</u>, directly contrary to the assertion of the Examiner. See column 1, "Field of the Invention" and column 3, line 30 of Moison et al. As such, the primary Moison et al. reference teaches directly against the combination required by these rejected claims, and the modification of the Moison et al. reference to

meet that combination would undermine the express function of the Moison et al. system. This is a controlling determinant against the Examiner's finding of obviousness.

Claims 33-34, 37, 39 and 44

These claims add the further limitation of a precursor material for generating the gas. The references relied upon in no way teach or suggest this claim limitation. The Examiner has refused to give weight to the limitations of these claims, despite the fact that they are positively recited elements of the claimed system. All elements of a claim must be taken into account when determining obviousness. The precursor material is an active component of the claimed system – it is reacted to produce the generated gas itself, and must be accounted for in the obviousness determination. Because the references do not teach or suggest the claimed systems including the precursor material, the Examiner's rejections of these claims are erroneous for this further reason.

Claim 40

This claim adds the further limitation of "a liquid received in said reaction chamber for absorbing microwave radiation directed into said reaction chamber." As disclosed in the application, this component of the system absorbs the microwave radiation to quickly generate heat, which assists in causing the rapid reaction of precursor material to generate the gas. Examiner has refused to give weight to this limitation, despite the fact that it is a positively recited element of the claimed system. All elements of a claim must be taken into account when determining obviousness. This liquid material is an active component of the claimed system, and must be accounted for in the obviousness determination. Because the references do not teach or suggest the claimed systems including the microwave-absorbing liquid, the Examiner's rejection of claim 40 is erroneous for this further reason.

For at least these reasons, it is submitted that the rejection of claims 32-34, 37-44 and 49 under 35 U.S.C. §103 is erroneous and should be reversed.

Issue 4 *Whether claims 35 and 36 are obvious under 35 U.S.C. 103(a) over Moisan et al. in view of Mutterer, Jr. et al., Warmbier and/or Lautenschlager et al. and further in view of Ayers (U.S. 5,158,656).*

This rejection adds the Ayers reference to the combination of references. The Examiner relies upon the Ayers reference as teaching the elements of claims 35 and 36, that is, fluidly coupling the gas generation system to a semiconductor fabrication device or a chemical vapor deposition reactor or oxidation furnace, respectively. In making this rejection, the Examiner asserts that it would be obvious to fluidly couple such devices to the modified system of Moisan et al. However, such a system is a waste gas remediation system. Thus, to sustain this rejection, it would have to be obvious to connect the output from a waste gas remediation system to the claimed devices used in semiconductor fabrication. Such a combination would not make sense to one skilled in the art.

For this reason at least, the rejection of claims 35 and 36 under 35 U.S.C. §103 is erroneous and should be withdrawn.

Issue 5 *Whether claims 47 and 50 are obvious under 35 U.S.C. 103(a) over Moisan et al. in view of Mutterer, Jr. et al., Warmbier and/or Lautenschlager et al. and further in view of WO 95/11750.*

The Examiner adds the WO 95/11750 to the prior-recited references, and relies upon it for teaching the elements of claims 47 and 50. The Examiner does not assert that this reference teaches or suggests a system configured to generate the high purity gas with a stringent low water vapor content (100 ppm or less) as required in claims 47 and 50, and the reference in fact does not teach or suggest such a limitation. As discussed above, none of the other references relied upon in this combination teaches or suggests such a feature, either.

For at least these reasons, the rejection of claims 47 and 50 under 35 U.S.C. §103 is erroneous and should be withdrawn.

Issue 6 *Whether claim 48 is unpatentable under 35 U.S.C. § 103(a) over Moisan et al. in view of Mutterer, Jr. et al., Warmbier and/or Lautenschlager et al. and further in view of Easly et al. (U.S. 3,889,182).*

The Easly et al. reference was added to the prior-recited references in this rejection and relied upon for its teachings relative to the limitation added in claim 48. This new reference was not relied upon for any teaching or suggestion as to a system configured to achieve a stringent low water vapor content gas as required by claim 48, nor could it be.

For at least these reasons, it is submitted that the rejection of claim 48 under 35 U.S.C. §103 is erroneous and should be withdrawn.

Conclusion

For the above reasons, each of the Examiner's rejections is in error and should be reversed. Applicant thus respectfully requests reversal of the present rejections and passage of the present application to allowance containing claims 11-21 and 32-50.

Respectfully Submitted,

By Kenneth A. Gandy

Kenneth A. Gandy
Registration No. 33,386
Woodard, Emhardt, Moriarty,
McNett & Henry, LLP
Bank One Center/Tower
111 Monument Circle, Suite 3700
Indianapolis, Indiana 46204-5137
(317) 634-3456

Claims Appendix

11. A chemical reactor system for generation of high purity gas, comprised of a source of microwave radiation, a microwave transparent, gas tight barrier, a microwave reflecting enclosure into which said source of microwave radiation is directed through said gas tight barrier and into a reaction zone within said microwave reflecting enclosure, a manifold for gas delivery adapted to receive generated gas from said enclosure, a solvent vapor removal device adapted to remove solvent vapor from the generated gas, a gas concentration sensor for sensing gas concentration in the generated gas, a feed-back control system adapted to control gas generation rate in said enclosure, and a supply vessel for containing a precursor material for forming said gas, said supply vessel fluidly connected to said reaction zone for feed of the precursor material to the reaction zone to generate the high purity gas, and wherein said system is configured to generate said high purity gas containing no more than 100 parts per million water vapor.

12. The system of Claim 11, wherein the microwave radiation source has a frequency of 0.9 GHz, or 2.41 to 10 GHz.

13. The system of Claim 11, wherein the microwave transparent barrier comprises a material selected from the group consisting of a tetrafluoroethylene polymer resin, fused silica, silicon dioxide, boron nitride, or graphite.

14. The system of Claim 11, wherein the microwave reflecting enclosure is constructed from an electrically conductive material with a conductivity of a least 10-3 ohm/cm.

15. The system of Claim 11, wherein the microwave reflecting enclosure has a smallest dimension of at least twice the wavelength of the microwave radiation.

16. The system of Claim 11 and also comprising a precursor material received in said supply vessel, and wherein the precursor material is selected from the group consisting of hypophosphorous acid, hypophosphoric acid, and an alkaline slurry of red phosphorous.

17. The system of Claim 11 wherein the vapor removal device contains silica gel.

18. The system of Claim 11, wherein the feedback control system includes a microprocessor controlled temperature feedback loop to a raw material feed pump, and a microwave radiation source power supply.

19. The system of Claim 11 wherein the feedback control system is adapted to modulate the electrical power to the microwave radiation source to maintain a constant gas delivery pressure.

20. The system of Claim 11 wherein the feedback control system is adapted to modulate the electrical power to the microwave radiation source to provide a variable gas flow rate.

21. The system of Claim 11 wherein the feedback control system is adapted to modulate the microwave radiation frequency to control the reaction product selectivity.

32. A chemical reactor system for generation of high purity gas for semiconductor fabrication, comprised of:

a source of microwave radiation;

a reaction chamber for receiving a precursor material for generating said gas, said reaction chamber adapted to generate said gas under pressure;

a microwave transparent, gas tight barrier through which said source of microwave radiation is directed into said reaction chamber;

a microwave reflecting enclosure into which said source of microwave radiation is directed;

a manifold for gas delivery adapted to receive the generated gas;

a gas concentration sensor for sensing gas concentration in the generated gas;

a solvent vapor removal device adapted to remove solvent vapor from the generated gas; and

wherein said system is configured to generate said high purity gas containing no more than 100 parts per million of water vapor.

33. The system of claim 32, also comprising a supply of precursor material coupled to said reaction chamber.

34. The system of claim 33, also comprising:

a feed-back control system to control gas generation rate in said reaction chamber.

35. The system of claim 32, also comprising a semiconductor fabrication device fluidly coupled to said manifold for delivery of the generated gas to the semiconductor fabrication device.

36. The system of claim 35, wherein said semiconductor fabrication device is a chemical vapor deposition reactor or an oxidation furnace.

37. The system of claim 32, also comprising a precursor material for generating said gas received within said reaction chamber.

38. The system of claim 32, also comprising a supply vessel for containing a liquid precursor material, and a pump fluidly coupled to said supply vessel and operable to pump the liquid precursor material from the supply vessel to the reaction chamber.

39. The system of claim 37, wherein said precursor material is suitable for generating phosphine gas.

40. The system of claim 37, also comprising a liquid received in said reaction chamber for absorbing microwave radiation directed into said reaction chamber.

41. A chemical reactor system for generation of a gas, comprised of:

a source of microwave radiation;

a reaction chamber for receiving a precursor material for generating said gas, said reaction chamber adapted to generate said gas under pressure;

a microwave transparent, gas tight barrier through which said source of microwave radiation is directed into said reaction chamber;

a microwave reflecting enclosure into which said source of microwave radiation is directed;

a manifold for gas delivery adapted to receive the generated gas;

a solvent vapor removal device adapted to remove solvent vapor from the generated gas;

a supply vessel fluidly connected to said reaction chamber and adapted to feed the precursor material to the reaction chamber for generation of said gas; and

wherein said system is configured to generate said gas containing no more than 100 parts per million of water vapor.

42. The system of claim 41, wherein said reaction chamber is further adapted to permit reflux of a liquid precursor material during generation of said gas.

43. The system of claim 41, also comprising a gas concentration sensor for sensing gas concentration in the generated gas.

44. The system of claim 41, also comprising the precursor material received in said supply vessel, and wherein the precursor material is selected from the group consisting of hypophosphorous acid, hypophosphoric acid, and an alkaline slurry of red phosphorous.

45. The system of claim 41, also comprising a source of diluent gas fluidly coupled to said manifold for mixing a diluent gas with the generated gas.

46. The system of claim 45, also comprising a diluent gas mass flow controller operably associated with said source of diluent gas, and a feed-back control system operable to control said mass flow controller to modulate the volume of diluent gas mixed with the generated gas in response to a generated gas concentration signal from said gas concentration sensor.

47. The system of claim 41, wherein said reaction chamber is defined within a first microwave transparent tube concentrically surrounded by a second microwave transparent tube, wherein said second microwave transparent tube is capable of withstanding higher pressures than said first microwave transparent tube.

48. The system of claim 41, wherein said reaction chamber is defined within a steel vessel having a microwave transparent window mounted thereon.

49. The system of claim 41, wherein said reaction chamber has a first portion into which said source of microwave radiation is directed, a second portion below said first portion for receiving the precursor material from the supply vessel, and a third

portion above the first portion and operable to receive overflow of refluxing reaction products from the first portion.

50. The system of claim 41, also comprising a pump fluidly coupled to said supply vessel and operable to drive a precursor material from the supply vessel to the reaction chamber at a constant rate.

Evidence Appendix

None

Related Proceedings Appendix

None